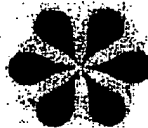


APPENDIX II

1.151 DECLARATION

T. ANDERSON



## M3: Motorola Mismatch Calculator

- Mismatch is a leading cause of yield loss and a determining factor of circuit performance in analog, mixed-signal ICs.
- Motorola has developed a new mismatch model that accounts for variations in physical process parameters and is accurate over geometry and bias.
- The designer need quick, easy access to the new model.
- The model is complex and automation is required.

$$\sigma_{Id}^2 = \sum_j (\partial I_d / \partial p_j)^2 \sigma_{pj}^2$$

J

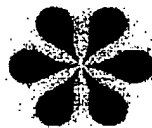
**AMSTC**  
Analog Mixed Signal Technology Center

Motorola Internal Use Only

<http://amstc.spa.mot.com>

BEST AVAILABLE COPY

**DigitalDNA**  
from Motorola



## Prior Art

- Prior art based on the simplistic Pelgrom model
  - P. G. Drennan, C. C. McAndrew "A Comprehensive MOSFET Mismatch Model," 1999 IEEE IEDM.
- Does not have a proper physical foundation and has gross errors in mismatch prediction.
- Prior art can't handle non-traditional devices such as graded channel (GCMOS & halo) and power MOSFETs.
- Inferior commercial tool is available from BTA Technology.

**AMSTC** → → →  
Analog Mixed Signal Technology Center

Motorola Internal Use Only

<http://amstc.sps.mot.com>

2  **DigitalDNA**  
from Motorola

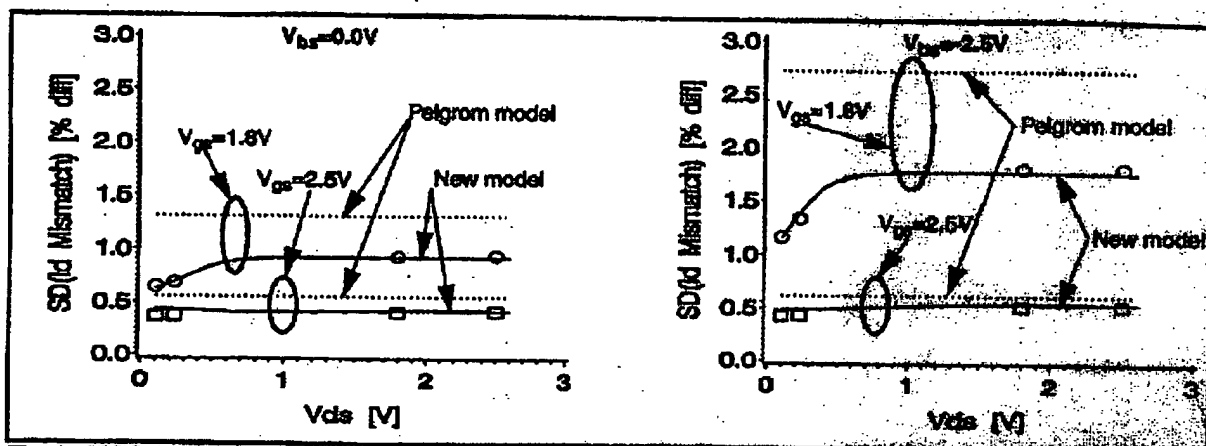


Fig. 1 nMOS  $I_d$  mismatch over bias,  $W/L=70.56\mu m$ . Circles are data for  $V_{gs}=1.8V$  and squares are for  $V_{gs}=2.5V$ .

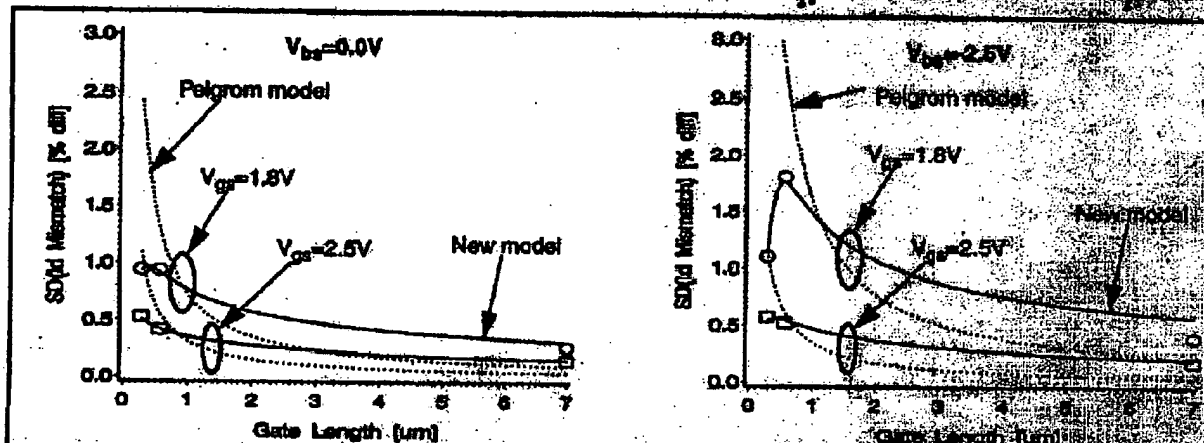


Fig. 2 nMOS  $I_d$  mismatch vs.  $L$ ,  $W=7\mu m$ ,  $V_{ds}=2.5V$ . Circles are data for  $V_{gs}=1.8V$  and squares are for  $V_{gs}=2.5V$ .

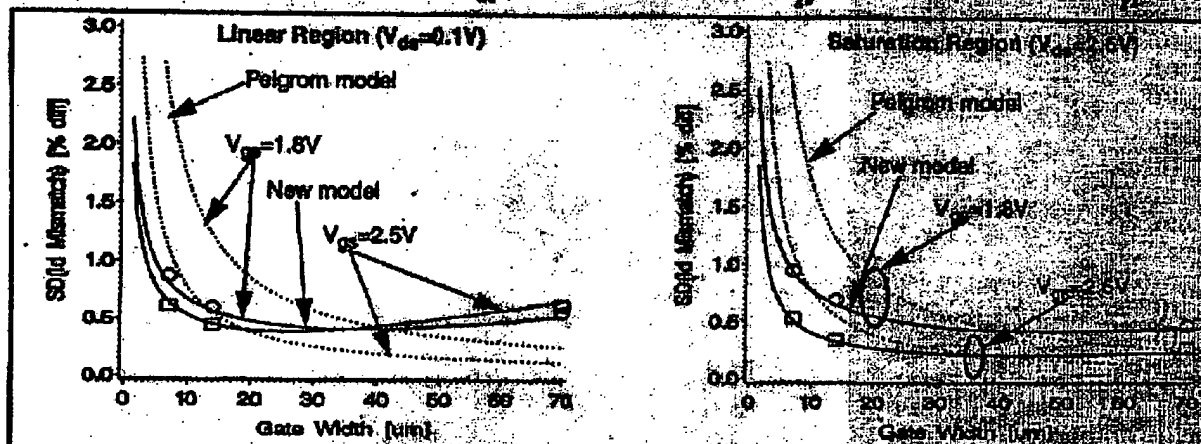


Fig. 3 nMOS  $I_d$  mismatch over  $W$ ,  $L=0.56\mu m$ ,  $V_{bs}=0.0V$ . Circles are data for  $V_{gs}=1.8V$  and squares are for  $V_{gs}=2.5V$ .



## M3: Proposed Solution

- Automate the Motorola Mismatch Model in the form of a web-based tool
- Three different solution types
  - Current Mirror (for designers)
  - Differential Pair (for designers)
  - Voltage Driven (for technology developers)
- Make the tool readily available throughout Motorola and only to Motorola
- Perform single mismatch predictions
- Perform multiple mismatch predictions by allowing the designer to sweep over bias and geometry

**AMSTC** → → →  
Analog Mixed Signal Technology Center

Motorola Internal Use Only

<http://amsta.sps.mot.com>

4  **Digital DNA**  
from Motorola



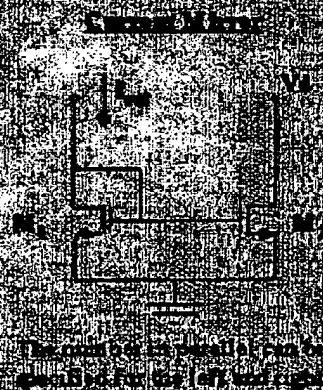
# Motorola Mismatch Calculator

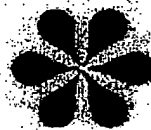
Mismatch FAQs  
AMSTO Publications  
Other Publications  
M3 Email

[ABOUT M<sup>3</sup>](#)[AMSTO Enabling Technologies](#)[AMSTO Home](#)

## Calculator

|     |     |     |     |     |
|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   |
| 6   | 7   | 8   | 9   | 0   |
| +   | -   | *   | /   | %   |
| 1/x | 1/y | 1/z | 1/w | 1/v |
| 1/u | 1/t | 1/s | 1/r | 1/q |
| 1/p | 1/o | 1/n | 1/m | 1/l |

[Help](#)[About](#)[Home](#)[Contact](#)

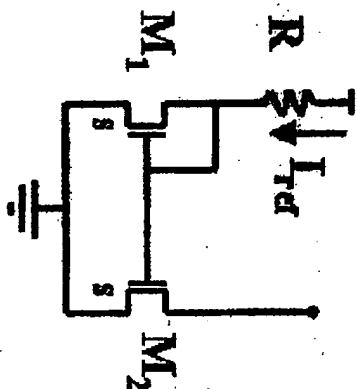


# Sample output

Data Entered into interface

## Two Outputs

- Total Mismatch (%)
- Without go
- $V_{D2} = V_g$



## Contributions to Mismatch

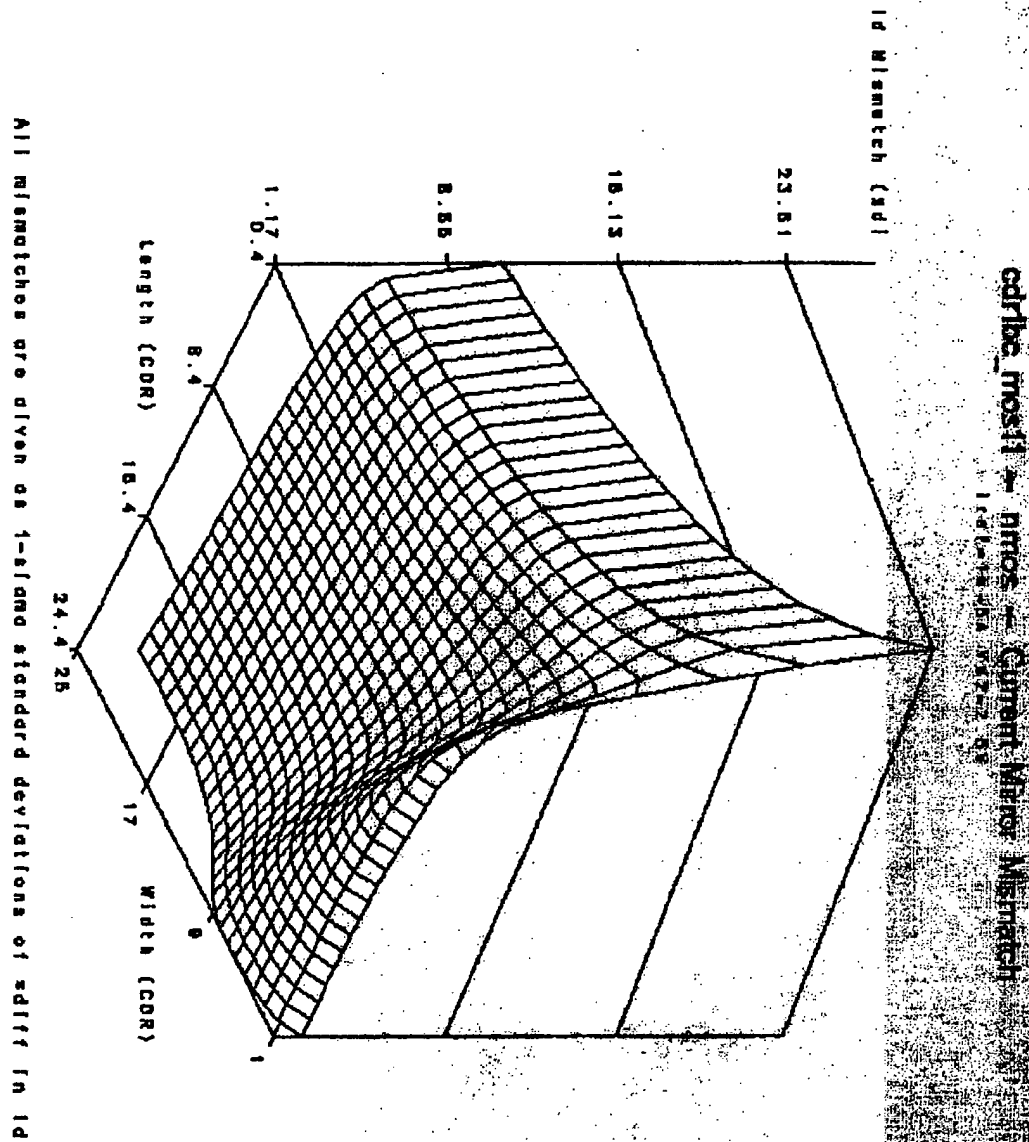
- Root Sum of Squares, add variances, not standard deviations!
- vti: Accounts for change in flat band voltage as a function of gate length

**AMSTC**  
Analog Mixed Signal Technology Center

Motorola Internal Use Only

<http://amstc.spa.mot.com>

**Digital DNA**  
from Motorola



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**